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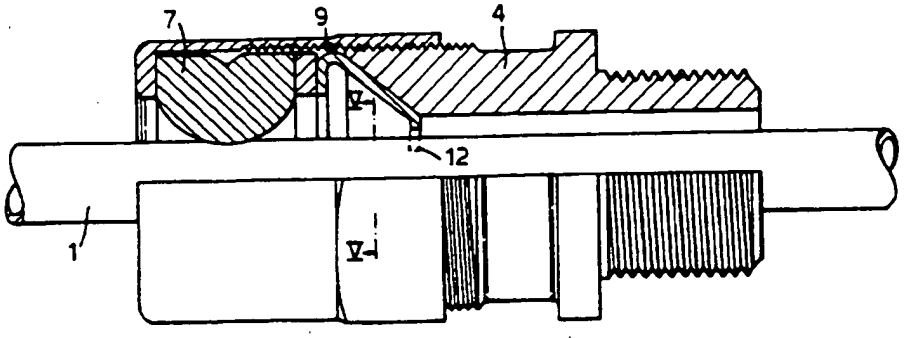
(54) Electric cable terminations and methods of making them

(57) A termination on an electric cable having an annular metal protective layer enclosed in an external sheath of polymeric material comprises a pair of annular components (gland members), at least one of which is metallic. These are drawn together by a screw-threaded engagement and hold in compression between them a deformable metal member comprising a base part bearing on the first of the two members and a number of fingers projecting longitudinally of the termination from the base part and radially inwardly and bearing on the second of the two members. At least one of these fingers has a sharp distal end which passes through the external sheath and is in direct mechanical engagement and electrical contact with the annular metallic protective layer. Thus the termination can be made without stripping the external sheath and without separating the parts of the gland, saving up to around half the termination time.

Fig.4.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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Fig.1.

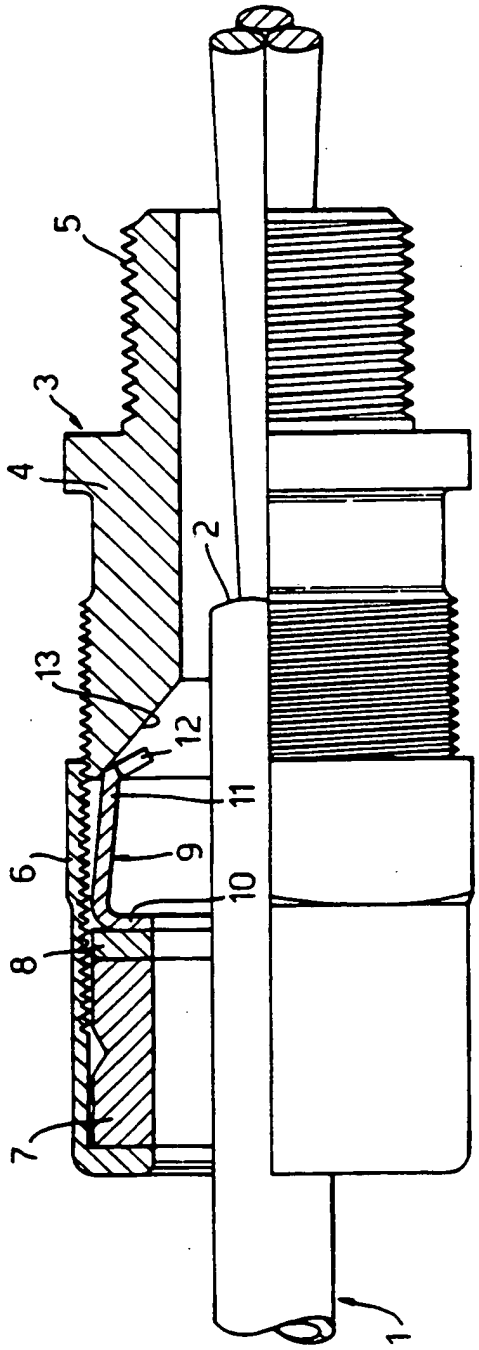

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Fig.2.

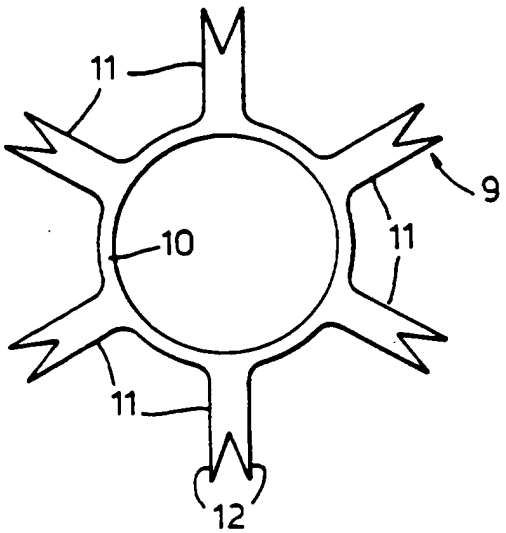

Fig.3.

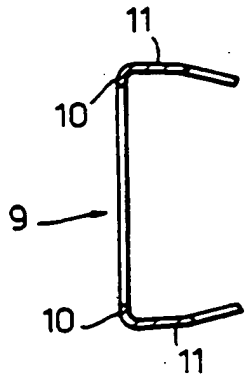

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Fig.4.

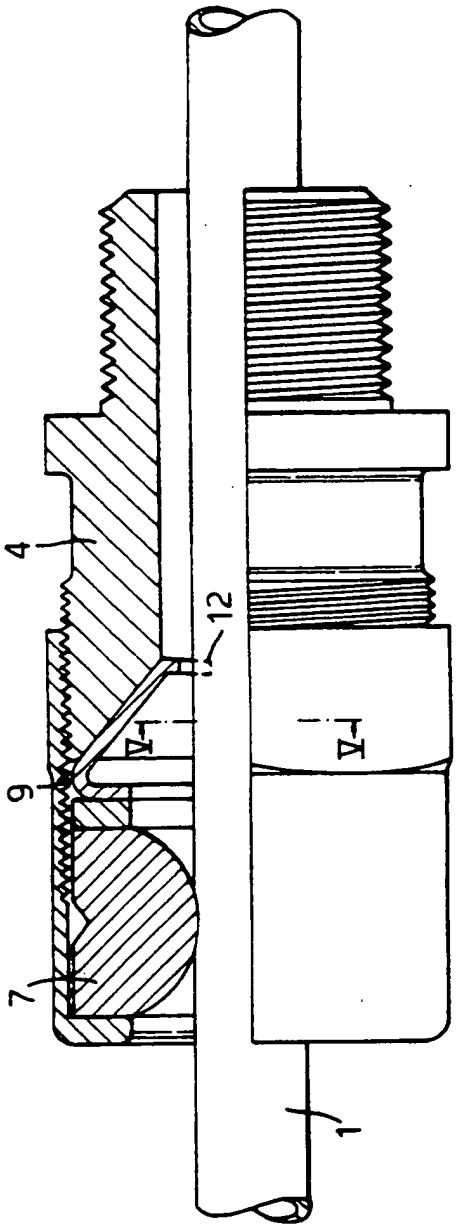


Fig.5.

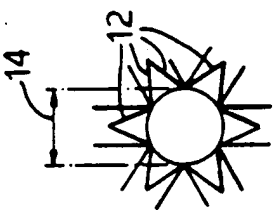
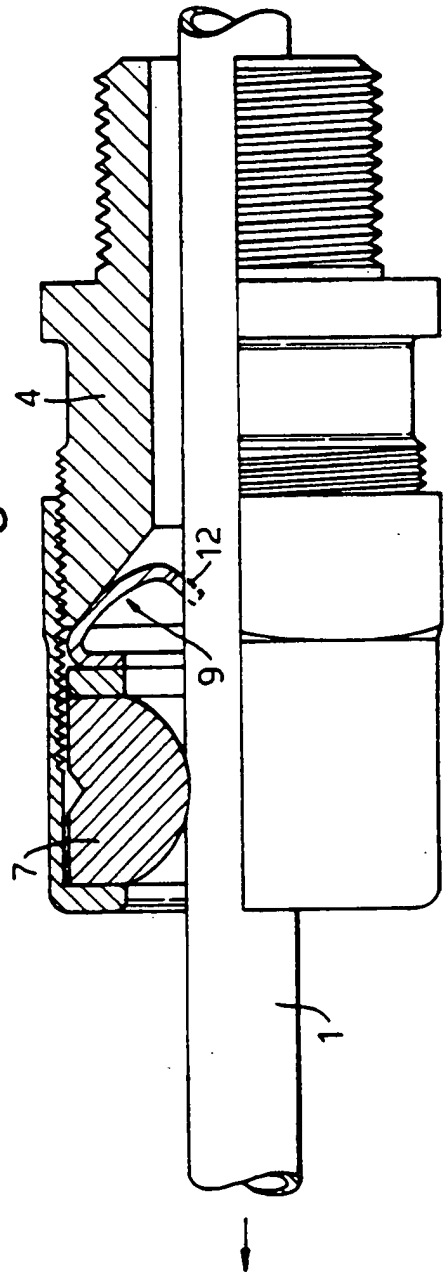


Fig.6.



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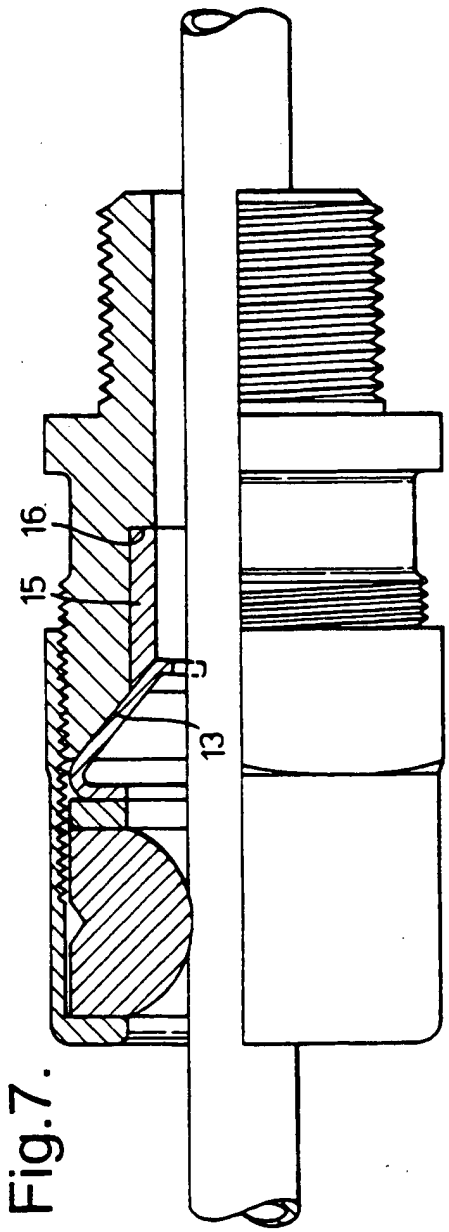

Fig.7.

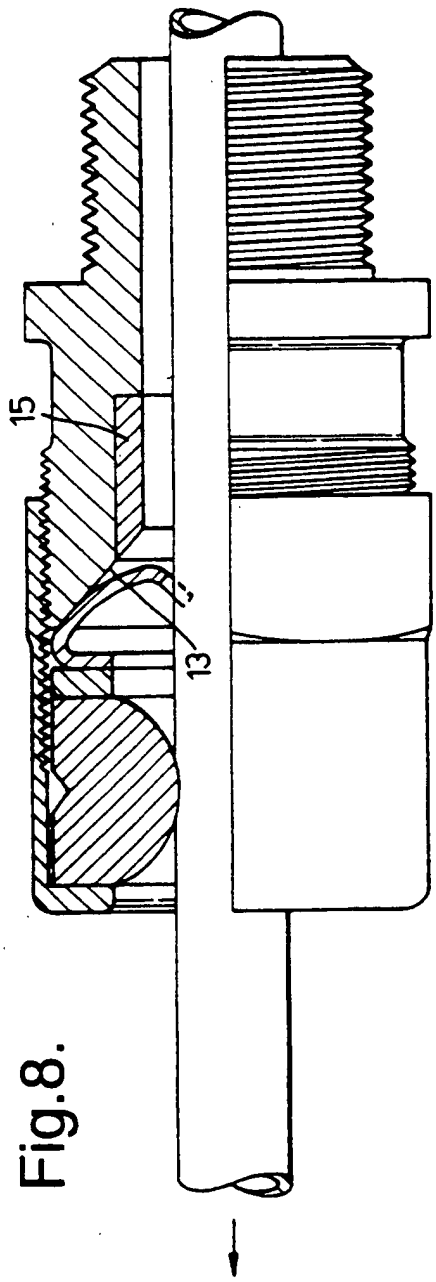

Fig.8.

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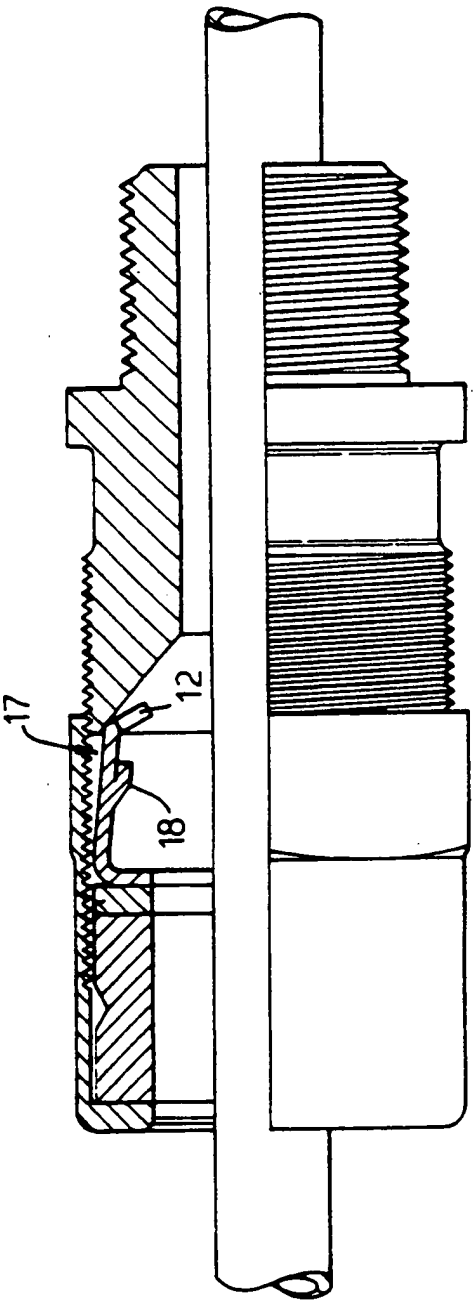
Fig.9.



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Electric Cable Terminations and Methods of Making Them

This invention relates to terminations by which electric cables are secured where they enter enclosures in which they may be jointed or may be connected to any appropriate electrical devices; it relates more particularly to terminations in which the cable has an annular metallic protective layer (such as a layer of armour wires, plain or interlocked tape armour, wire braid, or an aluminium sheath) that needs to be mechanically secured and electrically earthed (grounded) at the termination and which is enclosed in an external sheath of polymeric material.

In current practice, the external sheath and the metallic layer are cut back to expose a measured length of the metallic layer which is then prepared and fitted with appropriate gripping and connecting accessories; for example, wire armour will be cleaned and splayed out to allow it to be gripped between inner and outer annular members (a cone and a ring) with corresponding male and female tapered surfaces. These gripping and connecting accessories, and the space to accomodate them, contribute a significant part of the cost of the termination and the time taken to prepare the cable end and fit the accessories to it can be around half the time taken on site to make up the termination.

The present invention seeks to achieve substantial savings in installation time by simplifying the preparation of the cable end and to reduce costs by reducing the volume of the gripping and connecting accessories and reducing stock-holding requirements.

In accordance with the invention, a termination on an electric cable having an annular metal protective layer enclosed in an external sheath of polymeric material comprises a pair of annular components, at least one of which

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is metallic, drawn together by a screw-threaded engagement and holding in compression between them a deformable metal member comprising a base part bearing on the first of the two members and a number of fingers projecting longitudinally of the termination from the base part and radially inwardly and bearing on the second of the two members, at least one of these fingers having a sharp distal end which passes through the external sheath and is in direct mechanical engagement and electrical contact with the annular metallic protective layer.

Preferably each of the fingers has a sharp distal end which functions in this way. Preferably the number of fingers is as large as is consistent with avoiding interference between adjacent fingers; this may mean as few as three fingers in small sizes of termination and up to about six or eight on large ones. In very small terminations in which even three fingers might interfere, it may be necessary to shorten all but one of the fingers so that only one of them functions to penetrate the external sheath - the others may be blunt so as to bear on it and make some contribution to mechanical grip.

The screw-threaded engagement between the first and second annular members may be direct or indirect.

Preferably the orientation of the deformable metallic member is such that its fingers are closer to the end of the cable than its base is.

Preferably the second annular member has a female conical or otherwise tapered surface which engages the fingers of the deformable metal member, and preferably this second annular member, at least, is metallic. Preferably it is the "body" of a cable gland (terminator, in North American terminology) which is directly mounted in the wall of the

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enclosure to which the cable is terminated to form the most direct earthing path. The termination may include an inner seal, an outer seal or both, in each case of any conventional type. The first annular member may be, for example, a resilient ring forming the outer seal or a skid washer or other intermediate member bearing on it.

The appropriate annular member (in preferred forms the second) may be counterbored to form a shoulder to engage the coincident cut ends of the annular metallic protective layer and external sheath of the cable in order to positively locate the cable in a desired position.

To make the termination described, the cable end is prepared simply by making a single circumferential cut through the external sheath and the metallic protective layer together and removing both of them from the end portion. The first and second annular members are presented with the deformable metallic member already enclosed between them but in a condition in which they are only partly engaged and in which the fingers are positioned radially outwardly of their final positions so that there is clearance along the axis of the termination for entry of the cable, which is appropriately positioned. The first and second annular members are then simply drawn together by manipulation of the screw-threaded engagement between them until the fingers are driven through the external sheath and into the required engagement with the metallic protective layer.

Preferably the sharp distal end part of each (or the) finger is bent inwardly with respect to the remainder of the finger before tightening begins, preferably to the extent that when the parts are fully drawn together the end parts (or end part) will be approximately at right angles to the axis of the termination. Preferably the end of each finger

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(or the finger) is bifurcated and formed with two symmetrical sharp formations so that any circumferential deformation during tightening is likely to be symmetrical and confined to the end parts of the fingers.

In some cases it may be desirable to increase the range-taking capacity of the second annular member by providing it with an insert (of metal or a hard non-metal) to extend inwardly its surface that engages the deformable metal member when used with a cable with a diameter in the lower part of the range and which can be discarded when the cable is large enough not to require it.

In most cases there will be no difficulty in making finger ends that are sharp enough to penetrate the external sheath reliably but not so sharp as to risk damage to the metallic protective layer, but in a few cases (for example when the latter is a fine wire braid or a thin tape) it may be useful to provide each finger with at least one blunt barb positioned to engage the external sheath and limit penetration.

A preferred form of cable gland for use in making the termination of the present invention is the subject of another application filed today (no. 95 , agents ref. zz0040CPGp).

The invention will be further described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a half-sectioned view of one form of termination in accordance with the invention in a partially assembled state;

Figure 2 is a view of a blank for making a deformable metal member for use in this gland;

Figure 3 is a section though the deformable metal

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member as manufactured from this blank;

Figure 4 is a view, similar to Figure 1 and showing the termination in its completed condition;

Figure 5 is a diagram illustrating the control of finger clearances;

Figure 6 shows the same termination after testing by application of tension to the cable (a retention test);

Figures 7 and 8 are views, correponding to Figures 4 and 6 respectively, showing a first modified form of termination; and

Figure 9 is a view, corresponding to Figure 1, showing another modification.

In making the termination of Figures 1-6, the cable 1 is cut back by removing the external sheath and the underlying metallic protective layer to the position 2 and any underlying bedding layer that may be present (not shown) to the same or some other convenient position; this can normally be done by eye, without requiring any measurements. A gland 3 is passed over the end of the cable (without separating any of its parts) and appropriately positioned.

The gland comprises a gland body 4 of brass, aluminium alloy or other suitable metal having at one end a thread 5 (which may be parallel or tapered) for mounting in a correspondingly threaded opening in an enclosure wall (not shown). A gland nut 6, which may be metallic or non-metallic, is in direct screw-threaded engagement with the other end of the body and encloses a conventional "outer" seal comprising a sealing ring 7 of polychloroprene or other suitable resilient material and a skid washer 8 of brass or any other suitable metallic or non-metallic material. It also encloses a deformable metal member (an earthing clip) 9 which will be better understood by reference to figures 2-3.

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It comprises an annular base 10 which bears on the skid washer 8 and a number of fingers 11...11, each of which is bifurcated at its distal end to form a pair of spaced sharp points 12. The fingers 11...11 are bent from the plain of the blank so that they extend generally longitudinally of the gland (as manufactured) but with their distal ends bent radially inwards (Figure 3).

To satisfy requirements for mechanical strength, the deformable metal member may need to be relatively hard; stainless steel of appropriate gauge and temper is considered suitable. The use of such metals will result in an earth resistance greater (but not unacceptably greater - we estimate less than ten times greater) than for conventional terminations. If it is desired to approach closely the earth resistance of conventional terminations, then a member made of copper in a hard degree of temper may be satisfactory, or the use of composite materials, such as stainless steel laminated (or heavily plated) with copper, may be required; in both cases a plating of nickel or tin may be used to improve corrosion resistance.

Since there is no requirement to separate the parts of the gland during assembly of the termination, it may be possible to make the gland nut 6 captive on the body 4 as a precaution against the loss of any of the internal parts.

The body 4 is now screwed to the enclosure and the gland nut 6 tightened onto it (in whichever order is appropriate and convenient to the circumstances of the particular termination). Tightening of the gland nut has the effect of urging the fingers 11...11 into engagement with a conical face 13 in the body and so bending them inwards and driving their sharp distal ends 12 into and through the external sheath of the cable and into mechanical engagement

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and electrical contact with the underlying metallic protective layer. It is desirable for the hardness of the sealing ring 7 to be such that the bending of the fingers is complete, as seen in Figure 4 before the sealing ring 7 collapses onto the outer surface of the cable to complete the termination. Figure 5 (which is a diagrammatic view on the arrow V-V in Figure 4 but showing the diameter 14 of the smallest metallic layer for which the gland is suitable, rather than the overall cable diameter) illustrates the need for care in choosing the number and dimensions of the fingers to avoid risk of interference.

As illustrated by Figure 6, the earthing clip may be further deflected (deformed) by the application of tension to the cable, as in the prescribed "retention" tests, but such deformation, within practical requirements, need not compromise either the electrical or the mechanical capabilities of the termination (note that this drawing shows the termination after a retention test and with the gland nut slackened to the point at which the sealing ring 7 is just uncompressed).

Figures 7 and 8 show a modification in which a removable insert 15 is used to extend the tapered surface 13 radially inwards; this insert is utilised when the outside diameter of the cable being terminated is in the lower part of its range (say when the cable will pass through the bore of the gland) and discarded in other cases. With the insert removed, the shoulder 16 may act as an abutment to provide positive location of the cut end 2 of the cable sheath, if desired.

Figure 9 illustrates another modification in which the fingers of the earthing clip 17 are formed with blunt barbs 18 designed to engage but not penetrate the external

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sheath of the cable when the termination is completed in order to resist over-compression and reduse risk of damage if the metallic protective layer of the cable is relatively weak.

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CLAIMS

A termination on an electric cable having an annular metal protective layer enclosed in an external sheath of polymeric material comprising a pair of annular components, at least one of which is metallic, drawn together by a screw-threaded engagement and holding in compression between them a deformable metal member comprising a base part bearing on the first of the two members and a number of fingers projecting longitudinally of the termination from the base part and radially inwardly and bearing on the second of the two members, characterised in that at least one of these fingers has a sharp distal end which passes through the external sheath and is in direct mechanical engagement and electrical contact with the annular metallic protective layer.

2 A termination in accordance with claim 1 in which each of the fingers has a sharp distal end which functions as aforesaid.

3 A termination as claimed in claim 1 or claim 2 in which the orientation of the deformable metallic member is such that its fingers are closer to the end of the cable than its base is.

4 A termination as claimed in any one of claims 1-3 in which the second annular member has a female tapered surface which engages the fingers of the deformable metal member.

5 A termination as claimed in any one of claims 1-4 in which the second annular member, at least, is metallic.

6 A termination as claimed in any one of claims 1-5 in which on e of the annular membersis counterbored to form a shoulder to engage the coincident cut ends of the annular metallic protective layer and external sheath of the cable in order to positively locate the cable in a desired position.

7 A termination as claimed in any one of claims 1-6 in

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which the second annular member is the body of a cable gland which is directly mounted in the wall of the enclosure to which the cable is terminated.

8 A termination as claimed in any one of claims 1-7 in which the end part of the or each finger is approximately at right angles to the axis of the termination.

9 A termination as claimed in any one of claims 1-8 in which the end of the or each finger is bifurcated and formed with two symmetrical sharp formations.

10 A termination as claimed in any one of claims 1-9 in which at least one finger is formed with at least one blunt barb engaging the external sheath to limit penetration.

11 A cable termination substantially as described with reference to figures 1-6 or Figures 1-8 or Figures 1-6 and 9.

12 A method of making the termination claimed in any one of claims 1-11 in which the cable end is prepared simply by making a single circumferential cut through the external sheath and the metallic protective layer together and removing both of them from the end portion, presenting the said first and second annular members with the deformable metallic member already enclosed between them but in a condition in which they are only partly engaged and in which the fingers are positioned radially outwardly of their final positions so that there is clearance along the axis of the termination for entry of the cable, and drawing the first and second annular members together by manipulation of the screw-threaded engagement between them until the fingers are driven through the external sheath and into the required engagement with the metallic protective layer.

13 A method as claimed in claim 13 in which the sharp distal end part of each (or the) finger is bent inwardly with respect to the remainder of the finger before tightening

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begins.

14 A method of making a cable termination substantially as described with reference to Figures 1-6 or Figures 1-8 or Figures 1-6 and 9.

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Amendments to the claims have been filed as follows

CLAIMS

A termination on an electric cable having an annular metal protective layer enclosed in an external sheath of polymeric material comprising a pair of annular components, at least one of which is metallic, drawn together by a screw-threaded engagement and holding in compression between them a deformable metal member comprising a base part bearing on the first of the two members and a number of fingers projecting longitudinally of the termination from the base part in the direction such that its fingers are closer to the end of the cable than its base is, extending radially inwardly and bearing on the second of the two members, at least one of these fingers having a sharp distal end which passes through the external sheath and is in direct mechanical engagement and electrical contact with the annular metallic protective layer.

2 A termination in accordance with claim 1 in which each of the fingers has a sharp distal end which functions as aforesaid.

3 A termination as claimed in claim 1 or claim 2 in which the second annular member has a female tapered surface which engages the fingers of the deformable metal member.

4 A termination as claimed in any one of claims 1-3 in which the second annular member, at least, is metallic.

5 A termination as claimed in any one of claims 1-4 in which one of the annular members is counterbored to form a shoulder to engage the coincident cut ends of the annular metallic protective layer and external sheath of the cable in order to positively locate the cable in a desired position.

6 A termination as claimed in any one of claims 1-5 in which the second annular member is the body of a cable gland

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which is directly mounted in the wall of the enclosure to which the cable is terminated.

7 A termination as claimed in any one of claims 1-6 in which the end part of the or each finger is approximately at right angles to the axis of the termination.

8 A termination as claimed in any one of claims 1-7 in which the end of the or each finger is bifurcated and formed with two symmetrical sharp formations.

9 A termination as claimed in any one of claims 1-8 in which at least one finger is formed with at least one blunt barb engaging the external sheath to limit penetration.

10 A cable termination substantially as described with reference to figures 1-6 or Figures 1-8 or Figures 1-6 and 9.

11 A method of making the termination claimed in any one of claims 1-10 in which the cable end is prepared simply by making a single circumferential cut through the external sheath and the metallic protective layer together and removing both of them from the end portion, presenting the said first and second annular members with the deformable metallic member already enclosed between them but in a condition in which they are only partly engaged and in which the fingers are positioned radially outwardly of their final positions so that there is clearance along the axis of the termination for entry of the cable, and drawing the first and second annular members together by manipulation of the screw-threaded engagement between them until the fingers are driven through the external sheath and into the required engagement with the metallic protective layer.

12 A method as claimed in claim 11 in which the sharp distal end part of each (or the) finger is bent inwardly with

respect to the remainder of the finger before tightening begins.

13 A method of making a cable termination substantially as described with reference to Figures 1-6 or Figures 1-8 or Figures 1-6 and 9.

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